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In 2003, Massachusetts governor Mitt Romney proposed a plan for an infallible death penalty that required irrefutable scientific evidence, effectively removing any doubt regarding potential innocence in death penalty cases. Forensic science encompasses many scientific disciplines including natural sciences and pattern analysis, but not all such areas experience equal amounts of general acceptance or influence in criminal cases. While DNA analysis and fingerprint identification using the Integrated Automated Fingerprint Identification System (IAFIS) are both widely accepted forensic applications, recent events expose concerns regarding the authenticity of other disciplines such as hair and bite mark comparison. Before policymakers address the issue of a reinstated death penalty, they must carefully consider the merits of forensic science as well as the potential dangers. Existing issues and a history of wrongful convictions aided by flawed forensic testimony necessitate further investigation and critical analysis of forensic disciplines and the application of forensic evidence in criminal cases.

Keywords

forensic efficacy, fingerprint analysis, death penalty, DNA analysis

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In 2003, Massachusetts governor Mitt Romney proposed a plan for an infallible death penalty that required irrefutable scientific evidence, effectively removing any doubt regarding potential innocence in death penalty cases. Forensic science encompasses many scientific disciplines including natural sciences and pattern analysis, but not all such areas experience equal amounts of general acceptance or influence in criminal cases. While DNA analysis and fingerprint identification using the Integrated Automated Fingerprint Identification System (IAFIS) are both widely accepted forensic applications, recent events expose concerns regarding the authenticity of other disciplines such as hair and bite mark comparison. Before policymakers address the issue of a reinstated death penalty, they must carefully consider the merits of forensic science as well as the potential dangers. Existing issues and a history of wrongful convictions aided by flawed forensic testimony necessitate further investigation and critical analysis of forensic disciplines and the application of forensic evidence in criminal cases.

Introduction

In 1988, investigators used DNA evidence to convict Colin Pitchfork of two murders. For the first time in history, DNA evidence not only identified the true killer, but also exonerated the original suspect through DNA analysis (James, Nordby, & Bell, 2014). Fifteen years later, Massachusetts governor Mitt Romney proposed a reinstated death penalty in cases supported by irrefutable scientific evidence, namely DNA analysis, to ensure the state "never puts the wrong person to death" (Mansnerus, 2003, para. 3). This proposed higher standard for conclusive scientific evidence in death penalty cases may be well intentioned but it is misplaced. Scientific evidence is an invaluable tool within the criminal justice system; however, many forensic disciplines face increasing scrutiny regarding methodology and evidentiary value. These developments warrant further investigation in order to identify existing weaknesses and progressively improve the application of forensic science in all criminal cases so that wrongful convictions can be prevented.

Literature Review

The use of forensic science, where experts employ the scientific method to examine physical evidence in a criminal setting, is a relatively new addition to the court of law. The forensic sciences encompass a wide variety of disciplines including biology, chemistry, anthropology, entomology, and pattern evidence. While many of these research areas date back centuries, newer techniques such as DNA typing did not enter the courts until the mid-1980s. In recent decades, the prevalence of crime television shows and forensic testimony in high profile cases has heightened public interest and increased expectations for forensic evidence in criminal cases.

While some forensic disciplines continue to gain credence within the scientific community, others face increasing scrutiny. Recent studies have identified hundreds of wrongfully convicted persons exonerated by DNA evidence, suggesting methodological inconsistencies and positive identifications based on inaccurate conclusions, particularly in forensic disciplines that rely on visual pattern analysis (Hampikian, West, & Akselrod, 2011). This review explores the applications of forensic science in recent years, beginning with an overview of the role forensic testimony plays in the legal system and evidence admissibility. Further criteria examined for this analysis include the positive contributions of DNA evidence, concerns regarding false convictions, and quantitative studies on expert reliability in forensic disciplines that rely on pattern analysis.

A thorough evaluation of forensic evidence requires a basic understanding of evidence admissibility in courts and forensic expert qualifications. Page et al. (2011) reviewed 548 cases where courts challenged the admission of forensic identification evidence and evaluated the reasons cited for successfully excluding or limiting evidence in 81 of the cases. Reasons cited include witness reliability, failure to follow recognized standards, insufficient documentation, observer bias, and suspicious error rates. This review provides a foundation for subsequent literary sources and addresses the issue of false or inadmissible forensic evidence (Page, Taylor, & Blenkin, 2011).

DNA evidence is a decidedly accurate application of forensic science and plays a prominent role in overturning wrongful convictions. Hampikian et al. (2011) reviewed 194 exoneration cases aided by DNA evidence and identified multiple reasons for false convictions including misidentification by witnesses or victims and the misapplication of several forensic disciplines that rely on hair, bite mark, and fingerprint comparisons. The authors not only commend the practice of DNA testing for its inculpatory and exculpatory abilities, but they also chronicle the use of DNA evidence in real instances where courts first applied other types of forensic evidence incorrectly (Hampikian et al., 2011).

Previous studies established that certain forensic disciplines are questionable. These subsequent studies quantitatively analyze the reliability and bias of fingerprint experts, bite mark analysis, and suggested improvements in the field of firearms identification, respectively (Dror & Rosenthal, 2008). Dror and Rosenthal (2008) assessed the reliability and biasability of six fingerprint identification experts. The authors concluded that experts are still susceptible to bias despite generally consistent analyses, a determination that questions the use of individual judgments to make positive forensic identifications.

Holtkötter et al. (2013) investigated the use of bite mark analysis in forensic science and concluded that bite mark evidence is not a definitive form of identification and requires cautionary interpretation. Previous sources cite bite mark evidence as a factor in some wrongful convictions (Hampikian et al., 2011) and Holtkötter et al. (2013) obtained quantitative results that warrant continued scrutiny of this particular discipline. Concerns regarding other types of forensic evidence were not addressed but the authors suggested that bite marks may be more useful for obtaining biological evidence to analyze via DNA typing rather than for pattern analyses (Holtkötter et al., 2013). Wei et al. (2013) explored the possibility of an automated identification system to match consecutive matching striae (CMS) on bullet evidence to reduce the subjectivity of observer-based firearms identification. Although critics have not scrutinized this particular forensic discipline as extensively as hair or bite mark comparisons, improved identification methods hold implications for firearms as well as other types of pattern evidence. The Integrated Automated Fingerprint Identification System (IAFIS) is an existing database that identifies potential fingerprint matches, minimizing the work of the examiner who ultimately determines a match. Although individual judgment is still used for both types of evidence, this proposed CMS system borrows from existing fingerprint identification methods to improve other pattern evidence identification systems (Wei, Thompson, John, & Vorburger, 2013).

As the application of sciences in a forensic setting continues to evolve and expand, the scope of critical inquiries regarding methodology and evidence reliability must advance accordingly. Hampikian et al. (2011) demonstrate the importance of modern biological evidence and the dangers of misapplied forensics in their review of DNA exonerations, while Page et al. (2011) identify important trends concerning evidence admissibility. Additional quantitative studies further examined these questioned disciplines and the methods experts employ; researchers ultimately concluded that forensic evidence, especially pattern evidence, is subject to mistakes. In the studies that have been reviewed, the authors acknowledge the limitations of lab-controlled studies and the small scope of test subjects. The authors of these studies also ultimately arrived at similar conclusions: pattern evidence identification by a person, even a trained expert, is not always definitive and is susceptible to observer bias and human error (Hampikian et al., 2011). These results encourage future large-scale studies to expand on current findings and improve identification techniques for a number of forensic disciplines.

When considering new laws that require forensic evidence as a necessary standard of proof in death penalty cases, lawmakers must examine the merits of forensic science as well as the shortcomings. Forensic science is founded in many different areas of study, is constantly changing as new information becomes available, and holds the power to both exonerate and wrongfully convict individuals in a court of law, as demonstrated by these studies. This knowledge, in addition to recommendations for further studies, warrants careful consideration of future laws that fail to adequately consider the limitations of an otherwise valuable and progressive contribution to the justice system.

Discussion

Evidence Admissibility and Expert Reliability

The 1993 Supreme Court case *Daubert v. Merrell Dow Pharmaceuticals* introduced the *Daubert* test, a standard that determines the relevance and reliability of expert forensic testimony based on five factors: theory testability, use of control standards, peer review, error rate, and acceptance within the relevant scientific community (*Daubert v. Merrell Dow Pharmaceuticals*, 1993). In a study of 81 successfully challenged court cases following the *Daubert* decision, Page et al. (2011) identify the preceding factors as reasons judges excluded or limited forensic evidence; other factors cited include the inability of experts to explain methodology, insufficient documentation, and observer bias.

Assessment of six fingerprint experts' analyses by Dror and Rosenthal (2008) demonstrated the existence of biases and human error, although these conclusions also apply to other forensic disciplines. Any conclusion based on individual judgment or pattern analysis is subject to potential error and even standardized DNA analyses can pose concerns (Dror & Rosenthal, 2008). Notably, forensic evidence serves as circumstantial evidence and the probative value of physical evidence varies significantly based on contextual information. Forensic evidence alone cannot establish guilt or innocence; additional evidence is required to legally convict someone of a crime (James et al., 2014; Mansnerus, 2003).

Pattern-Based and Comparison Evidence

While certain forensic disciplines with origins in biology, chemistry, and other natural sciences are generally reliable and readily verified, pattern-based forensic sciences face increasing scrutiny. Hampikian et al. (2011) determined that, of 146 wrongful convictions where sufficient data existed for analysis, experts provided invalid forensic testimony in the following disciplines in the specified percentages of the cases: serology (38%), hair comparison (22%), bite mark comparison (3%), and fingerprint analysis (2%). Serology is no longer recognized as a relevant discipline of forensic science due to the superiority of DNA typing (Hampikian et al., 2011); however, fingerprint analysis, hair and bite mark comparison, and firearms identification are still considered valid disciplines and all require a visual examination. In a collective process known as ACE-V (analysis, comparison, evaluation, and verification), a trained examiner analyzes both exemplar (known) and questioned (unknown) samples, compares their findings for each sample, and evaluates the information to identify or exclude the exemplar as the source of the questioned sample; the examiner may also determine that the results are inconclusive or that insufficient detail exists to make an identification. A second examiner then repeats this process to verify the results (James et al., 2014).

Hair and bite mark comparisons, in particular, present various issues. Both disciplines lack adequate scientific research and, although forensic odonatologists assume individual bite marks are unique, neither discipline produces a definitive identification. Holtkötter et al. (2013) report that significant levels of distortion may occur when a bite mark transfers to the skin and obscure any distinguishable features, "indicating that tooth characteristics may not be reliably transferred and recorded" (p. 61). Likewise, a hair comparison examiner may only conclude that the questioned sample is "consistent with" the exemplar; unless the root is present to warrant DNA typing, an examiner cannot individualize a hair sample (Hampikian et al., 2011, p. 106).

Fingerprint Analysis

Fingerprint analysis and firearms identification methodologies are more systematic than those of hair and bite mark comparison, although both still rely on visual pattern-analysis by trained experts. The case discussed below demonstrates that even trusted forensic disciplines are not infallible.

Forensic examiners base fingerprint analyses on the biological premise that no two fingerprints are exactly alike: Friction ridge details develop in the womb and these unique details that "vary within certain boundaries" remain unchanged except for permanent scarring (James et al., 2014, p. 345). Fingerprints are primarily a means of identification, often used to identify or eliminate suspects in a criminal case. An initial search using the IAFIS database narrows the field of possible matches, and a trained fingerprint examiner uses ACE-V to identify or exclude an exemplar print as the source of an unknown print.

Although fingerprint analysis is a historically reliable forensic application, there is potential for multiple issues to arise throughout the examination process. The examiner must first determine the orientation of the print and whether sufficient ridge detail exists. In some instances, visual enhancement techniques can obscure minute details or a partial print may display insufficient minutiae points for a positive identification (James et al., 2014). Because friction ridge details and minutiae "vary within certain boundaries," it is possible for an examiner to mistakenly match parts of two individual fingerprints to a single, latent print, especially when the quality of the questioned print is relatively poor.

In a widely publicized forensic mishap, investigators discovered several latent prints connected to the 2004 Madrid train bombings and the FBI identified a match through IAFIS. Officials promptly arrested Brandon Mayfield—a U.S. citizen who had converted to Islam and the person they believed was responsible for the bombings. However, Spanish authorities later discovered the partial print actually belonged to an Algerian national (James et al., 2014). The minutiae within the discernable areas of the noticeably smudged latent print appeared to match part of Mayfield's print. Although mistakes like this are rare in fingerprint identifications, this case emphasizes the importance of evidence quality and sufficient detail required to make a positive identification in a field where the potential for human error exists. Wei et al. (2013) propose an automated system similar to IAFIS to identify CMS on firearms evidence, another discipline that relies on pattern recognition. Studies like this acknowledge the limitations of existing practices and strive to improve the forensic sciences.

DNA Evidence

While many forensic disciplines originated within the criminal justice system, DNA analysis emerged in the 1980s as a result of biological research when British geneticist Sir Alec Jeffreys developed the innovative technique of DNA "fingerprinting," now referred to as DNA typing. This technique was first used in a criminal case to identify Colin Pitchfork as the murderer of two young girls (Hampikian et al., 2011). Genes, or hereditary sequences of DNA subunits called nucleotides, are located on chromosome sites called loci; geneticists refer to these repetitive nucleotide sequences at specific loci in non-coding regions of DNA (junk DNA) as short tandem repeats (STRs).

DNA typing is a way to quantify STR genetic variations. Although many people share the same number of STR at a particular locus, the probability that individuals share the same number of STR at all loci decreases exponentially as the examiner studies multiple loci sites. Therefore, a forensic biologist must develop an STR profile of at least 13 core loci to identify an exemplar sample as the source of the questioned sample (Hampikian et al., 2011).

The high level of variation of STR profiles among individuals leaves little room for ambiguity, and in past decades, DNA analysis has helped exonerate hundreds of wrongfully convicted persons; however, DNA analysis is not infallible. Hampikian et al. (2011) note that despite DNA's reputation as an irrefutable form of identification, experts provided inaccurate testimony in four known cases. One analyst failed to disclose that the DNA was only a partial match, a second failed to provide accurate population statistics, and a third failed to disclose an additional exclusionary result. Additionally, one analyst failed to separate a DNA mixture containing both the offender and victim's DNA, resulting in a contaminated sample and misinterpretation of the results presented at trial (Hampikian et al., 2011).

Conclusion

Policymakers should not support a scientifically irrefutable death penalty reinforced by physical evidence when evidence indicates that forensic science, however invaluable, is susceptible to error. Forensic science encompasses a variety of scientific disciplines and, although Romney's proposal identifies DNA analysis as the ideal form of conclusive proof, DNA alone cannot prove a defendant's guilt or innocence. Furthermore, DNA and other forms of forensic evidence do not exist in all criminal cases and when they do, the quality and quantity of available evidence ultimately determines whether experts may reach a definitive conclusion.

Pattern-based forensic techniques require further research to fully understand the effects of observer bias on expert interpretation. All forensic disciplines require a more structured approach to ensure that all forensic scientists, including DNA analysts, apply standardized, evidence-based practices to prevent erroneous testimony. The *Daubert* (1993) test exists to identify scientific weaknesses before experts testify in court; however, a history of wrongful convictions in the United States based on flawed forensic science exposes multiple problems associated with forensic evidence. Instead of pursuing a scientifically irrefutable death penalty, policymakers must first address the issue of flawed forensic science in all criminal cases to ensure that no innocent person receives an unjust sentence, an issue that requires a thorough review of all forensic disciplines and the application of forensic evidence in courts.

References

Daubert v. Merrell Pharmaceuticals, Inc. (1993). 509 U.S. 579.

Dror, I., & Rosenthal, R. (2008). Meta-analytically quantifying the reliability and biasability of forensic experts. *Journal of Forensic Sciences (Wiley-Blackwell)*, *53*(4), 900-903.

Hampikian, G., West, E., & Akselrod, O. (2011). The genetics of innocence: analysis of 194 U.S. DNA exonerations. *Annual Review of Genomics & Human Genetics*, *12*(1), 97-120.

Holtkötter, H., Sheets, H. D., Bush, P. J., & Bush, M. A. (2013). Effect of systematic dental shape modification in bitemarks. *Forensic Science International*, *228*(1-3), 61-69.

James, S., Nordby, J.J. & Bell, S. (2014). *Forensic science: An introduction to scientific and investigative techniques* (11th ed.). Boca Raton, Fla.: CRC Press.

Mansnerus, L. (2003, November 2). States seek ways to make executions error free. *New York Times*. p. 5.

Page, M., Taylor, J., & Blenkin, M. (2011). Forensic identification science evidence since Daubert: Part II-judicial reasoning in decisions to exclude forensic identification evidence on grounds of reliability. *Journal of Forensic Sciences (Wiley-Blackwell)*, *56*(4), 913-917.

Wei, C., Thompson, R. M., John, S., & Vorburger, T. V. (2013). Automatic identification of bullet signatures based on consecutive matching striae (CMS) criteria. *Forensic Science International*, *231*(1-3), 137-141.

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